CHAPTER

7

CONFIGURING SERVER STORAGE, BACKUP, AND PERFORMANCE OPTIONS

After reading this chapter and completing the exercises you will be able to:

- Explain basic and dynamic disks
- Partition, format, and manage basic disks and convert them to dynamic disks
- Create and manage simple, spanned, striped, RAID-5, and mirrored dynamic disks
- Mount a drive
- Manage removable storage and set up media pools
- Perform disk backups
- Tune server performance
- Configure Windows 2000 Server for an uninterruptible power supply (UPS)

When Intel-based servers first appeared on the scene, disk storage options were limited because disk sizes were relatively small at 20–40 MB. At 20 GB and beyond, disk storage has come a long way and is arguably one of the most important server elements that you will configure and maintain. The lifeblood activities of a server are typically related to providing files, databases, and applications to clients—and all of these require disk storage. Windows 2000 Server crosses an important threshold from Windows NT Server because it offers new ways to integrate and manage storage, such as through removable storage. The implementation of removable storage allows the appropriate kind of storage to be matched to specific types of data. These new disk storage and removable storage capabilities enable you to apply lower total cost of ownership (TCO) through better storage management.

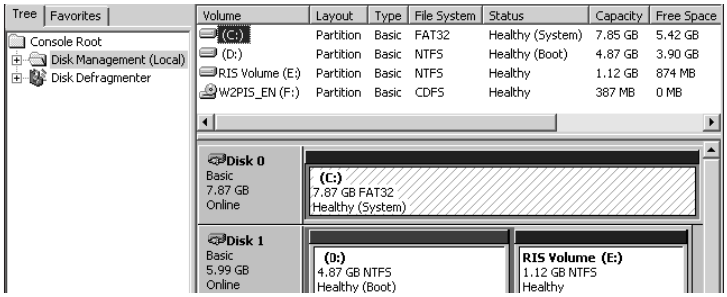
In this chapter, you learn how to use disk storage options that include disk mirroring, disk striping, and RAID level 5 fault tolerance. You will learn removable storage management techniques and how to perform server backups as security against losing important data. Finally, you will learn the basics of optimizing server performance (see Chapter 14 for more advanced optimizing techniques).

Basic and Dynamic Disks

Windows 2000 treats disk storage according to two classifications: basic disks and dynamic disks. A **basic disk** is one that uses traditional disk management techniques, such as partitioning, and provides capabilities similar to those available in Windows NT 4.0. A **dynamic disk** is one that does not use traditional partitioning, which means that there is virtually no restriction to the number of volumes that can be set up on one disk. Dynamic disk architecture provides new flexibility for handling large disk storage.

Basic Disks

Because a basic disk uses traditional disk management techniques, it is partitioned and formatted, and can be set up to employ disk sets. It recognizes primary and extended partitions, disk striping (RAID level 0), disk mirroring (RAID level 1), and disk striping with parity (RAID level 5). When you first install Windows 2000 Server, it uses the basic disk structure. Also, if you upgrade any of the Windows NT Server 4.0, 3.51, or 3.5 operating systems to Windows 2000 Server, disk storage is converted to basic disks.



Disk Partitioning

A hard disk that is low-level formatted can be set up for one or more file systems, such as FAT or NTFS. The process of marking or "blocking" a group of tracks and sectors in preparation for a file system is called **partitioning**. Each partition appears as a logical drive, for example partitioning a single disk into drive C for FAT and drive D for NTFS. A partition is made out of free or unallocated space on the disk—that is, space not yet partitioned for use by any file or operating system.

When a drive is partitioned, a **master boot record (MBR)** and a **partition table** are created in the beginning track and sectors on the disk. The MBR is located in the first sector

and track of the hard disk and has startup information about partitions and how to access the disk. The partition table contains information about each partition created, such as the type of partition, size, and location. Also, the partition table provides information to the computer about which partition to access first.

When you partition a disk, leave 1 MB or more of the disk space free. This is the amount of workspace that Windows 2000 Server needs to convert a basic disk to a dynamic disk, in case you want to upgrade later.

A partition is created by the Disk Management tool, which is an MMC snap-in (see Figure 7-1) and is also accessed from the Computer Management tool. (The Computer Management tool is opened by clicking Start, pointing to Programs, pointing to Administrative Tools, and clicking Computer Management. Click Storage in the Computer Management tool to access Disk Management.) When you install this MMC snap-in, consider installing the Disk Defragmenter snap-in at the same time so that both disk tools are available in one MMC configuration.

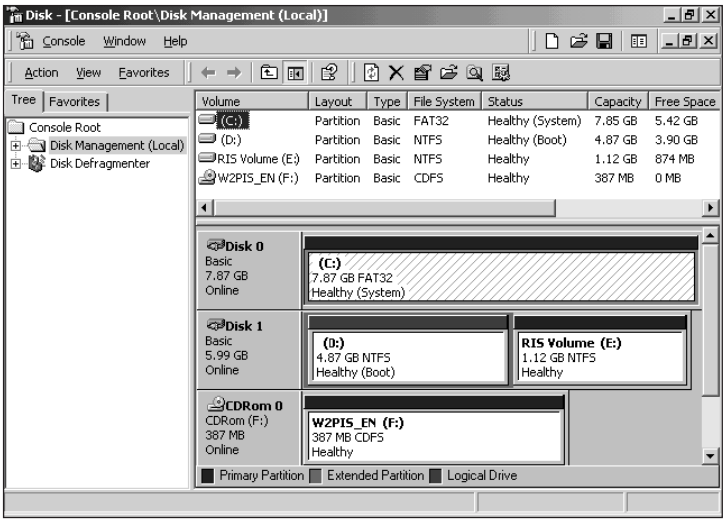


Figure 7-1 Disk Management and Disk Defragmenter snap-ins installed in the MMC

To create a partition in the Disk Management tool, right-click the unallocated disk space that is displayed in the Disk Management snap-in and click Create Partition (or click the disk space, click Action, point to All Tasks, and click Create Partition). The Create Partition Wizard steps you through the process. Try Hands-on Project 7-1 to practice creating a partition and formatting it.

You can use the View menu to customize the display of the snap-in. For example, the View menu Settings option enables you to customize the legend and the scaling. Also, you can access the properties of any disk by right-clicking the disk and clicking Properties. The Properties dialog box gives you access to repair tools, hardware information and drivers, disk-sharing parameters, and Web-sharing parameters.

You can delete a partition from the Disk Management snap-in as well. To delete a partition, right-click the partition you want to delete. The partition will have a dark gray border and shading to indicate that you have selected it. Click Delete Partition on the shortcut menu. The Disk Management snap-in gives you a warning that data will be lost. Click Yes to continue the delete process. After the partition is deleted, the Disk Management snap-in displays a box showing the partition with a black bar on top and indicating that the disk space is unallocated.

When you make a change to the disk configuration and it is not automatically updated in Disk Management, rescan the disks by clicking the Disk Management Action menu and clicking Rescan Disks.

Primary and Extended Partitions

A partition may be set up as primary or extended. A **primary partition** is one from which you can boot an operating system, such as MS-DOS or Windows 2000 Server. Or it may simply hold files in a different file system format. When you boot from a primary partition, it contains the operating system startup files in a location at the beginning of the partition. For example, the startup files for Windows 98 include Io.sys and Msdos.sys. For Windows 2000, those files include Boot.ini, Ntldr (treated as a .sys file), and Ntdetect.com. A partition containing the startup files is called a **system partition**. A single disk must have one primary partition, and can have up to four.

Removable media, such as Zip or Jaz disks, can only be set up as a basic disk primary partition.

An **extended partition** is created from space that is not yet partitioned and is added onto a primary partition. The purpose of an extended partition is to enable you to exceed the four-partition limit of a hard disk. On some computers, an extended partition is not bootable (cannot be a system partition). However, either a primary or an extended partition can hold the Windows 2000 operating system files, which are the files you loaded into the \Winnt folder during the installation (see Chapter 5). There can be only one extended partition on a single basic disk. The partition containing the operating system files is called the **boot partition** by Microsoft. When you work with the terms boot partition and system partition, it helps to remember that their contents are the opposite of what is intuitive—the boot files are on the system partition, and the system files are on the boot partition.

Creating an extended partition is similar to creating a primary partition. In the Disk Management snap-in, right-click unallocated space and click Create Partition. The Create Partition Wizard is started and displays a dialog box that enables you to specify a primary or extended partition (see Figure 7-2). After you specify the type of partition, there is a dialog box to specify the partition's size and another that enables you to review your selections before creating the partition.

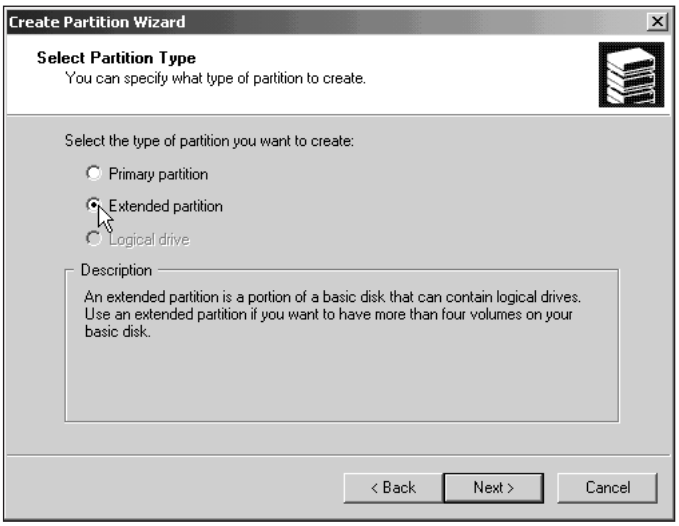


Figure 7-2 Creating an extended partition

A computer with multiple partitions boots from the partition that is designated as the **active partition**, which must also be the system partition containing the startup files. To determine which partition is designated as active, look for the "(System)" designation in the Disk Management pane that gives information about the disk's size and file system (see Figure 7-3). For example, the active (system) partition in Figure 7-3 is the one designated as drive C:. Also notice that the boot partition holding the \Winnt folder is shown as drive D:. Hands-on Project 7-2 shows how to use the Disk Management snap-in to mark a partition as the active partition.

Formatting

If you do not format a partition when it is created, it still needs to be formatted for a particular file system. As you learned in Chapter 1, Windows 2000 supports the FAT16, FAT32, and NTFS file-system formats. **Formatting** is a process that creates a table containing file and folder information for a specific file system in a partition. The process also creates a root directory (folder) and a volume label. Once a partition is formatted, it is called a **volume** and can be assigned a drive letter. Assigning a drive letter makes it easier to refer to the volume, for example assigning it drive letter C.

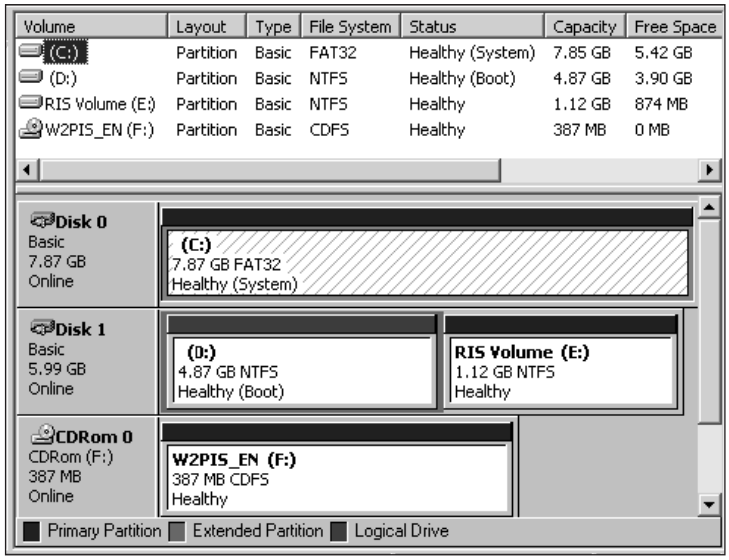


Figure 7-3 System and boot partitions

By Microsoft's definition, a basic disk volume is any of the following: primary partition, drive in an extended partition, volume set, stripe set with parity, and mirror set.

To format a partition that is not already formatted, open the Disk Management snap-in, right-click the partition to be formatted, and click Format. You will need to specify a volume label, the file system to use, and the allocation unit size (see Figure 7-4). Also, you can select to use the quick format option and to enable file and folder compression.

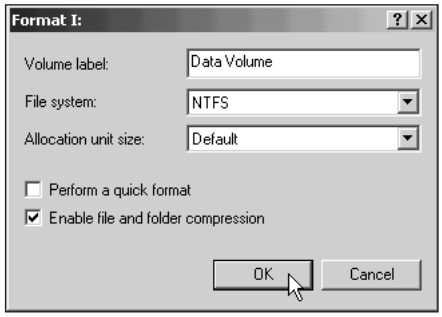


Figure 7-4 Formatting a partition

When you format a partition, avoid using the quick format option, because it does not check for bad sectors during the format.

You can assign a different drive letter to a partition by right-clicking the partition in the Disk Management snap-in, clicking Change Drive Letter and Path, and clicking Edit to change the letter. You also have the option of changing the drive path. Hands-on Project 7-3 enables you to practice changing a drive letter.

Whenever you make a change in the Disk Administrator, for example to partition a drive, format a partition, or assign a new drive letter, update the emergency repair disk (ERD) to reflect the change (see Chapter 5).

Volume and Stripe Sets

Volume sets and stripe sets are disk management concepts that are used in Windows NT Server 4.0 and earlier. A **volume set** consists of two or more partitions that are combined to look like one volume with a single drive letter. A **stripe set** is two or more disks that are combined like a volume set, but that are striped for RAID level 0 or RAID level 5 (see Chapter 2). Windows 2000 Server provides backward compatibility with volume and stripe sets that have previously been created through Windows NT. Windows 2000 Server enables you to use an existing volume or stripe set carried over from a Windows NT upgrade until one or more disks in a set fail. For this reason, it is important that you regularly back up a volume or stripe set until you convert it to a dynamic disk structure. Also, if there is a disk failure before you have an opportunity to convert, you can use the Disk Management snap-in to delete a basic disk volume or stripe set and create a dynamic disk spanned volume or stripe set (see the section on Dynamic Disks that follows).

Converting Disks

Converting a basic disk to a dynamic disk is accomplished from the Disk Management snap-in. When you convert a disk, the process does not damage data in any way, but dynamic disks are not compatible with dual-boot systems. Right-click the basic disk that you want to convert, and click Upgrade to Dynamic Disk (make sure that the disk has 1 MB or more free space).

Make sure that you right-click the disk, for example Disk 0 (see Figure 7-3), and not the volume, for example (C:), or else the upgrade option will not be displayed.

There are circumstances when you may need to change a dynamic disk back to a basic disk, such as when you want to implement a dual-boot setup, or when you want to remove Windows 2000 Server from the computer so that a different operating system—such as Windows 98—can be loaded. If you need to revert back to a basic disk, it is necessary to delete the dynamic volume and destroy its data in the process. A dynamic disk can be converted back to a basic disk by using the following steps:

1. Back up all data on the dynamic disk volume before you start.
2. Delete the dynamic disk volume, using the Disk Management snap-in, by right-clicking the volume and clicking Delete Volume.
3. Click the disk, click the Action menu, and click Restore Basic Disk Configuration.
4. Use the Disk Management snap-in to partition and format the disk, for example for FAT32.

Dynamic Disks

A dynamic disk does not use traditional partitioning, which makes it possible to set up a large number of volumes on one disk and provides the ability to extend volumes onto additional physical disks. There is an upward limit of 32 disks that can be incorporated into one spanned volume. Besides volume extensions and spanned volumes, dynamic disks support RAID levels 0, 1, and 5. Dynamic disks can be formatted for FAT16, FAT32, or NTFS and are used when you do not implement a dual-boot system. Also, dynamic disks can be reactivated, should they go offline because they have been powered down or disconnected.

If a disk is reported as offline or missing in the Disk Management tool, reactivate it with care if you did not intentionally power it down or disconnect it, because the disk may be corrupted. When you reactivate a corrupted disk, Windows 2000 runs a "checkdisk" utility (described later) to repair files and folders. To reactivate a disk via the Disk Management tool, right-click the disk and click Reactivate Disk.

Basic disks can be converted to dynamic disks after you install Windows 2000 so that you can take advantage of the richer set of options associated with dynamic disks. There are five types of dynamic disk configurations: simple volumes, spanned volumes, mirrored volumes, striped volumes, and RAID-5 volumes. The functional concepts of these disk configurations are similar to those used for Windows NT 4.0 compatible basic disks, but the Windows 2000 dynamic disks have better disk management options and do not use partitioning. For example, the dynamic disk equivalent of a basic disk volume set is called **spanned volumes**, and the equivalent of a basic disk stripe set is called **striped volumes.**

On dynamic disks, instead of using the basic disk terminology of boot partition and system partition, the volume that contains the \Winnt folder of system files is called the boot volume, and the volume that contains the files used to boot the computer is called the system volume.

Simple Volume

A **simple volume** is a portion of a disk or an entire disk that is set up as a dynamic disk. If you do not allocate all of a disk as a simple volume, you have the option to later take all or a portion of the unallocated space and add it to an existing simple volume, which is called extending the volume. A simple volume does not provide fault tolerance, because it cannot be set up for any RAID level (see Chapter 2).

You might create a simple volume when you have only one disk drive on the server. Another situation in which you might set up a simple volume is when you first set up a server on one basic disk, convert the disk to a simple volume, and later add a second disk to mirror the first (see Chapter 2). Hands-on Project 7-4 enables you to practice setting up a simple volume using the Disk Management snap-in. To extend a simple volume via the Disk Management snap-in, right-click the volume that you want to extend and click Extend Volume.

Spanned Volume

A spanned volume contains 2 to 32 dynamic disks that are treated as one volume (see Figure 7-5). For example, you might create a spanned volume if you have three small hard disks, 1 GB, 1.5 GB, and 2 GB. Another reason to use a spanned volume is if you have several small free portions of disk space scattered throughout the server's disk drives. You might have 600 MB of free space on one drive, 150 MB on another, and 70 MB on a third. All of these free areas can be combined into a single 820 MB spanned volume with its own drive letter, with the advantage that you reduce the number of drive letters needed to make use of the space.

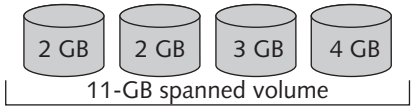


Figure 7-5 Spanned volume

As you add new disks, the spanned volume can be extended to include each disk. Volumes formatted for NTFS can be extended, but those formatted for FAT16 and FAT32 cannot. The advantage of creating spanned volumes is the ability to more easily manage several small disk drives or to maximize the use of scattered pockets of disk space across several disks.

The disadvantage of using a spanned volume is that if one disk fails, the entire volume is inaccessible. Also, if a portion of a spanned volume is deleted, the entire disk set is deleted. For these reasons, avoid placing mission-critical data and applications on a spanned volume.

The spanned volume might be used to store data that is already backed up on another medium, such as tape. For instance, the previous year's accounting data might be stored on a spanned volume. The data is already saved on tape, but a copy is left on disk for fast lookup and retrieval.

Creating a spanned volume involves selecting unallocated space on the disk that is to be in the volume, clicking the Action menu, pointing to All Tasks, and clicking Create Volume. In the Create Volume Wizard, specify Spanned volume. To extend a spanned volume, right-click the volume and click Extend Volume.

Striped Volume

As you learned in Chapter 2, RAID level 0 is disk striping. The main purpose for striping disks in a volume is to extend the life of hard disk drives by spreading data equally over two or more drives. Spreading the data divides the drive load so that one drive is not working more than any other. Another advantage of striping is that it increases disk performance. Contention among disks is equalized and data is accessed faster for both reads and writes than when it is on a single drive, because Windows 2000 can write to all drives at the same time. Striping has been used successfully on mainframes and minicomputers for years as a way to enhance disk performance.

In Windows 2000 Server, striping requires at least two disks and can be performed over as many as 32. The total of striped disks is called a striped volume. Equal portions of data are written in 64 KB blocks in rows or stripes on each disk. For example, consider that you have set up striping across five hard disks and are working with a 720 KB data file. The first 64 KB portion of the file is written to disk 1, the next 64 KB portion is written to disk 2, the third portion is written to disk 3, and so on. After 320 KB are spread in the first data row across disks 1 through 5, the next 320 KB are written in 64 KB blocks in the second row across the disks. Finally, there will be 64 KB in the third row on disk 1 and 16 KB in the third row on disk 2 (see Figure 7-6).

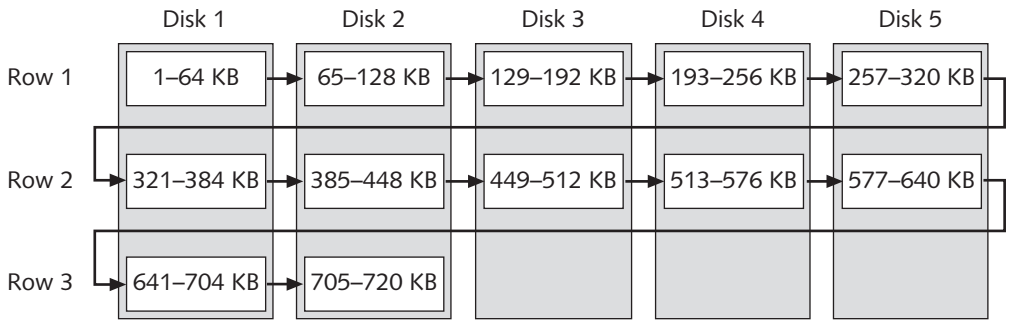


Figure 7-6 Disks in a striped volume

Because of its high performance, striping is useful for volumes that store large databases or for data replication from one volume to another. Striping is not a benefit when most of the data files on a server are very small, such as under 64 KB.

Data can be lost when one or more disks in the striped volume fail, because the system has no automated way to rebuild data. If you use striping to increase disk performance for a critical database, consider frequently backing up that database on tape (see later in this chapter) or through the Microsoft File Replication service (see Chapter 10).

A striped volume is created through the Disk Management snap-in. To create a striped volume, select free space on one disk, click Create Volume, and use the Striped volume option in the Create Volume Wizard.

RAID-5 Volume

Fault tolerance is better for a RAID-5 volume than for a simple striped volume. A **RAID-5 volume** requires a minimum of three disk drives. Parity information is distributed on each disk so that if one disk fails, the information on that disk can be reconstructed. The parity used by Microsoft is Boolean (true/false, one/zero) logic, with information about the data contained in each row of 64 KB data blocks on the striped disks. Using the example of storing a 720 KB file across five disks, one 64 KB parity block is written on each disk. The first parity block is always written in row 1 of disk 1, the second is in row 2 of disk 2, and so on, as illustrated in Figure 7-7.

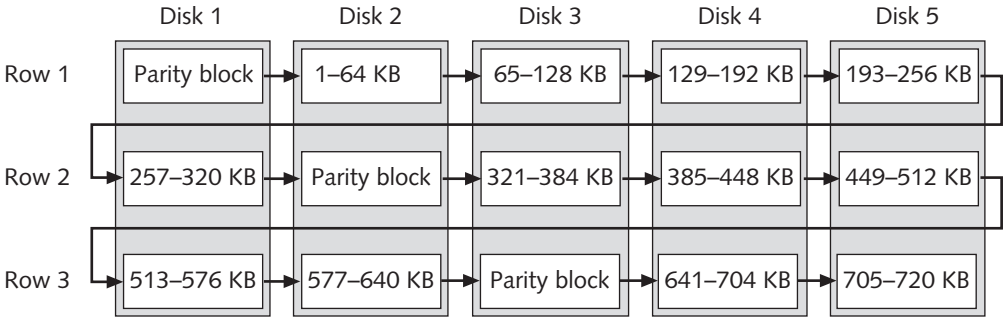


Figure 7-7 Disks in a RAID-5 volume

When you set up a RAID-5 volume, the performance is not as fast as with a striped volume, because it takes longer to write the data and calculate the parity block for each row. However, accessing data through disk reads is as fast as for a striped volume. RAID-5 is a viable fault tolerance choice for mission-critical data and for applications when full mirroring is not feasible due to the expense. It works well with disk arrays that are compatible with RAID-5. A RAID-5 volume is particularly useful in a client/server system that uses a separate database for queries and creating reports, because disk read performance is fast for obtaining data. In applications such as a customer service database that is constantly updated with new orders, disk read performance will be slower than with striping without parity.

If you create a RAID-5 volume, consider adding 12 MB or more of RAM, because RAID-5 uses more memory than mirroring or simple striping. Also, RAID-5 takes up disk space for the parity information.

The amount of storage space used is based on the formula $1/n$ where n is the number of physical disks in the volume. For example, if there are four disks, the amount of space taken for parity information is 1/4 of the total space of all disk drives in the volume. This means you get more usable disk storage if there are more disks in the volume. A set of eight 2 MB disks yields more usable storage than a set of four 4 MB disks in RAID-5.

Use the Disk Management snap-in to create a RAID-5 volume. To start, right-click the free space on a disk that is to be part of the volume, click Create Volume, and select the RAID-5 volume option in the Create Volume Wizard.

Mirrored Volume

As you learned in Chapter 2, disk mirroring involves creating a shadow copy of data on a backup disk and is RAID level 1. Only dynamic disks can be set up as a **mirrored volume** in Windows 2000 Server. It is the most guaranteed form of disk fault tolerance because the data on a failed drive is instantly recovered from the mirrored drive. Also, disk read performance is the same as reading data from any single disk drive. The disadvantage of mirroring is that the time to create or update information is doubled because it is written twice, once on the main disk and once on the shadow disk. However, a disk write in mirroring is normally faster than writing to disk when you use RAID-5. A mirrored volume cannot be striped and requires two dynamic disks.

A mirrored volume is particularly well suited for situations in which data is mission-critical and must not be lost under any circumstances, for example customer files at a bank. It also is valuable for situations in which computer systems must not be down for long, such as for medical applications or in 24-hour manufacturing. The somewhat slower update time is offset by the assurance that data will not be lost and that the system will quickly be back on line after a disk failure. However, if fast disk updating is the most important criterion for disk storage, such as when copying files or taking orders over a telephone, then a striped volume may be a better choice than a mirrored volume.

The Windows 2000 Server system and boot partitions can be in a mirrored volume, but they cannot be in a striped or RAID-5 volume.

A mirrored volume is created through the Disk Management snap-in. To create the volume, right-click free space on one disk, click Create Volume, and choose the Mirrored volume option in the Create Volume Wizard.

Disk Performance and Repair

Disk drives that are over 80 percent full also are subject to increased mechanical wear. When a disk drive failure occurs, it is most likely to be a read head that has physically touched the disk platter. In all cases this causes damage to the platter, sometimes resulting in the release of metal fragments within the sealed module of the disk unit. One way to increase disk performance and extend the life of hard disks is to make sure that one disk is not accessed and working harder than other disks in a multiple-disk server. Creating striped volumes and

RAID-5 volumes are two ways to equalize the disk load. If neither of these methods is employed, then you should consider monitoring disk usage and manually relocating files on a periodic schedule. By relocating files you can distribute disk access more evenly. Also, dividing disks onto different adapters enables you to increase performance (see Chapter 2).

Extensive fragmentation of files on a disk is another cause of extra wear. **Disk fragmentation** exists when the files on a disk gradually become spread throughout the hard drive, with empty pockets of space scattered throughout. Fragmentation occurs normally over time, the result of creating new files and deleting files. Full and fragmented drives cause the read head to move across the disk more extensively than in situations where disks are maintained regularly. **Defragmenting** a disk is a process used to reorganize files to reduce the number of empty spaces between files. Windows 2000 Server includes the Disk Defragmenter as an MMC snap-in. The Disk Defragmenter includes a tool to analyze a disk to determine the amount of fragmentation (see Figure 7-8) and another tool to defragment a disk. Try Hands-on Project 7-5 to practice using both tools.

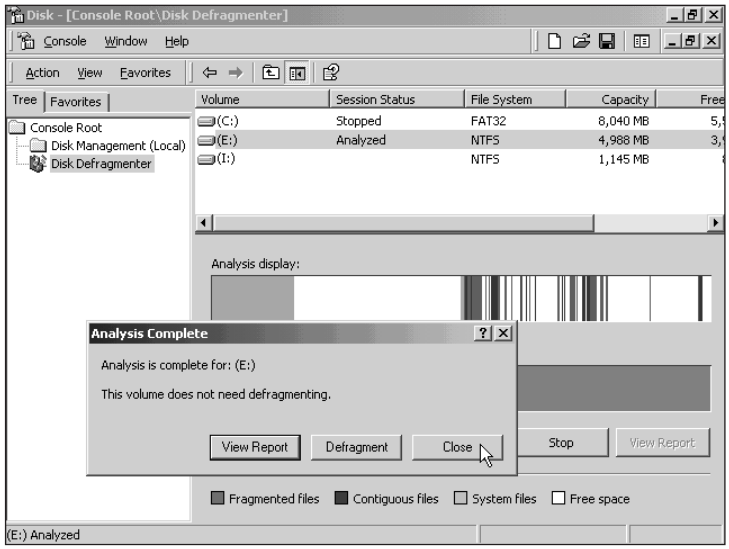


Figure 7-8 Analyzing a disk's fragmentation

On a busy server, drives should be defragmented every week to two weeks. On less busy servers, defragment the drives at least once a month.

Sometimes disk performance is affected by files that are corrupted or when the file allocation table has lost pointers to certain files. You can correct these problems and maintain the integrity of the data by periodically running the "checkdisk" utility, called chkdsk,

from the Start button, Run option. Chkdsk also starts automatically when you boot Windows 2000 Server and the boot process detects file allocation table or file corruption, for instance in the system files. The chkdsk utility is much more robust in Windows 2000 and Windows NT than it is in other versions of Windows. In Windows 2000 Server it can be used to check FAT, NTFS, or both file systems (on a dual-boot computer). When the file system is FAT, the utility checks the file allocation table, folders, files, disk sectors, and disk allocation units. In NTFS it checks files, folders, indexes, security descriptors, user files, and disk allocation units.

Plan to run chkdsk when there are no users on the server, and lock the disk from use until the process is finished. Also, run chkdsk using the /f switch, which causes it to lock the disk and fix errors that it finds. If you do not use the /f switch, chkdsk may incorrectly identify and fix bogus errors in open files.

If you suspect there is physical damage on a disk, use chkdsk with the /r switch to identify bad sectors. A disk that has a high number of bad sectors, such as several hundred thousand, may need to be replaced. You can use the Recover command in the Command Prompt window to attempt to recover files in a physically damaged area, but use Recover on one file at a time. The format of the Recover command is: Recover [drive and path] *filename*. You cannot use wildcard designations, such as *, with Recover. Table 7-1 shows the switches associated with chkdsk.

Allow plenty of time for chkdsk to run on large disk systems, such as a system having over 5 or 10 GB. If you have multiple disks, you may want to stagger running chkdsk, on different disks for each week. Also, the presence of some bad sectors is normal. Many disks have a few bad sectors that are marked by the manufacturer during the low-level format and on which data cannot be written.

When chkdsk finds lost allocation units or chains, it prompts you with the Yes or No question: Convert lost chains to files? Answer Yes to the question so that you can save the lost information to files. The files that chkdsk creates for each lost chain are labeled Filexxx.chk and can be edited with a text editor to determine their contents.

Table 7-1 Chkdsk Switch and Parameter Options

Switch/Parameter	Purpose
[*volume*] (such as C:)	Specifies that chkdsk only check the designated volume
[*filename*] (such as *.dll)	Enables a check of the specified file or files only
/c	For NTFS only, chkdsk uses an abbreviated check of the folder structure
/f	Instructs chkdsk to fix errors that it finds and locks the disk while checking
/i	For NTFS only, chkdsk uses an abbreviated check of indexes
/L:*size*	For NTFS only, enables you to specify the size of the log file created by the disk check
/r	Searches for bad sectors, fixes problems, and recovers information (when not possible; use the Recover command on separate files)
/v	On FAT shows the entire path name of files; on NTFS shows cleanup messages associated with errors
/x	Dismounts or locks a volume before starting (/f also dismounts or locks a volume)

Mounting a Drive

Windows 2000 enables you to mount a drive as an alternative to giving it a drive letter. A **mounted drive** is one that appears as a folder and that is accessed through a path like any other folder. You can mount a basic or dynamic disk drive, a CD-ROM, or a Zip drive. Only an empty folder on a volume formatted for NTFS can be used for mounting a drive. Once a drive is mounted, other drives can be added to the same folder to appear as one drive. There are several reasons for using mounted drives. The most evident reason is that Windows operating systems are limited to 26 drive letters; mounting drives enables you to reduce the number of drive letters in use, because mounted drives are not associated with letters. Another reason for creating a mounted drive is for user home folders that are stored on the server. A **home directory** or **home folder** is a server folder that is associated with a user's account and that is a designated workspace for the user to store files. As server administrator, you might allocate one drive for all user home folders and mount that drive in a folder called Users. The path to the drive might be C:\Home or C:\Users. In another situation, you might have a database that you want to manage as a mounted drive so that it is easier for users to access. Also, by mounting the drive, you can set up special backups for that database by simply backing up its folder. Try Hands-on Project 7-6 to mount a drive.

Managing Removable Storage

Removable storage media (tapes, CD-ROMs, CD-RWs, and magnetic disks such as Zip or Jaz disks) are used to access data in real time, for data archiving, and for data backups. The selection of what media to use is related to factors that include how often the data must be

accessed, how much data must be stored, and how fast the data must be available. For example, for full system backups and for many forms of archiving that require large storage but that are accessed infrequently, you will most likely use tapes. Many organizations use tape archives to store large system accounting and tax information for seven years or more, for example. In a small or medium-sized organization, you might archive data to CD or to a Zip disk because the storage needs are smaller. If your organization uses removable media for real-time data access, then CD or Zip media provide faster access than tape.

Understanding Libraries

A media **library** is storage media and the drive (or drives) used by the media. Windows 2000 Server supports two types of media libraries: robotic and stand-alone drive. A **robotic library** is one in which multiple removable media can be mounted and dismounted automatically. For example, in an organization, a complete backup of one or more servers might require the use of multiple tapes. A robotic tape changer can be set up to mount the first tape, dismount it when it is full, and mount the next tape until the backup is completed. A CD-ROM or CD-RW jukebox (see Chapter 2) can be used in the same way to automatically make multiple CD-ROMs or CD-RWs available. A **stand-alone drive library** is one in which the removable media are manually inserted one at a time as needed.

Understanding Media Pools

The media within each type of library are managed by using media pools. A **media pool** consists of media that are used for the same purpose and that are managed in the same way. The backup tapes used by an organization are one example of a media pool. Another media pool might consist of CD-ROMs that are used to provide real-time access in a robotic library, for example to provide reference information at a school's library or to provide access to book catalogs from other libraries. Windows 2000 Server classifies media pools into two broad categories: application media pools and system media pools. An application media pool is one that is automatically created by a software application, for example by a client/server application. Windows 2000 Server includes two applications that create application media pools, the Windows 2000 Server Backup tool (discussed later in this chapter) and the Windows 2000 Server Removable Storage Manager. For example, when you create backups for your organization's server, the Backup tool automatically creates an application media pool called Backup.

A system media pool consists of all other media that are created in some other way, such as when you manually create a CD-ROM or CD-RW through a copying process. There are three types of system media pools: import, free, and unrecognized. An import media pool is one or more media that were created through one media pool and are now being imported into another pool, such as tapes in a media pool used for server backups that are now being imported into a different media pool that is used for long-term archiving in a vault. A free media pool contains media that have been used previously in the same or different media pool, but that are free to be copied over because they no longer contain useful information. Free media also consist of unrecognized media that have been initialized for use in the free

media pool. An unrecognized media pool is simply new media that have not been used, such as new tapes.

Understanding Media Classification

Removable media can be classified as either physical or logical, depending on the management properties and the application that is managing the media. *Physical media* are media you can touch, such as tapes or Zip disks, and they are linked to a library. This is the most common classification with which you will work. The *logical media* classification is used when one medium can hold information from two different media pools. For example, if your organization is very small and has a limited budget, you might put backup and archive information on the same tape, such as a 20 GB Travan tape. Another possibility is to use a magnetic disk (or perhaps an optical disc one day) that can store information on two sides, where information on one side is in one media pool and information on the other side is in a different media pool.

Creating a Media Pool

A media pool is created by using the Removable Storage snap-in in the MMC. This snap-in enables you to create new media pools, manage media pools, and specify the physical location of a library. It also offers a window from which to view operator requests. For example, if a user requests data from a CD-ROM that is not mounted, a request is issued in the console window to notify the server operator that he or she needs to insert the CD-ROM.

The following general steps illustrate how to create a new media pool:

1. Install the Removable Storage snap-in in the MMC or access it from the Computer Management tool.
2. Double-click Removable Storage in the left pane's tree. Right-click Media Pools in the left pane and click Create Media Pool.
3. Make sure the General tab is displayed (see Figure 7-9).
4. Enter a name for the media pool, enter a description, specify the type of media, and specify how media are allocated (for example, obtaining media from the free media pool).
5. Click the Security tab to specify which groups of users can access and manage the media pool, such as Administrators and Backup Operators.

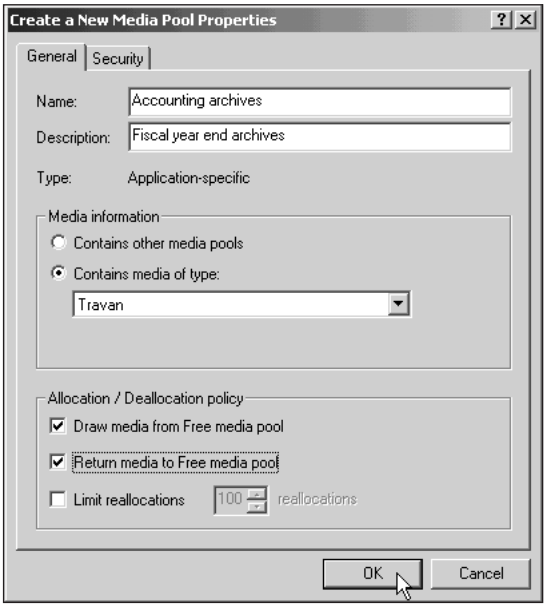


Figure 7-9 Setting up a new media pool

Disk Security Through Backup

One of the best ways to make sure you do not lose valuable information on a hard disk is to fully back up information, using backup tapes. In Chapter 2, you learned how to select and install a tape drive and SCSI adapter. Tape backups can be performed from the server or from a workstation connected to the server. There are several advantages to performing backups from a tape drive installed in the server:

- There is no extra load on the network from traffic caused by transferring files from the server to a tape drive on a workstation.
- Equipping each server with its own tape drive gives you a way to perform backups on a multiple server network even if one of the tape drives fails on a server. Backups can be performed from the tape drive on one of the other servers.
- Backing up from a tape drive on a server provides more assurance that the Registry is backed up, since access to the Registry is limited to backups performed at the server. The **Registry** contains vital information about a server's setup.

The advantage of performing backups from a workstation connected to the server is that you can perform all backups from one place, instead of walking to each server to start backups. Besides the extra network load, a disadvantage is that there is a possibility that an intruder can tap into the network and obtain backup data going from the server to the workstation.

Backup Options

The Windows 2000 Server backup software recognizes five backup options, which are variations of full or incremental backups. A **full backup** is a backup of an entire system, including all system files, programs, and data files. A full backup in Windows 2000 Server is called the *normal* backup, which is the same as a full file-by-file backup. A normal backup is a backup of all files that you have selected, usually an entire partition or volume. The normal backup changes each file's archive bit to show that it has been backed up. The advantage of performing full backups each night is that all files are on one tape or tape set.

An **incremental backup** only backs up files that are new or that have been updated. Windows 2000 Server has an *incremental* option that backs up only files that have the archive attribute. When it backs up a file, the incremental backup removes the archive attribute to show that the file has been backed up. A *differential* backup is the same as an incremental backup, but it does not remove the archive attribute. Incremental or differential backups are often mixed with full backups. The advantage of the differential backup is that only the most recent full backup and the most recent differential backup are required to restore data. That saves time over incremental restores, that require a full backup and all the incremental backups back to the last full backup.

Another Windows 2000 Server option is the *copy* backup, which backs up only the files or directories selected. The archive attribute, showing that a file is new or updated, is left unchanged. For example, if the archive attribute is present on a file, the copy backup does not remove it. Copy backups are used in exceptional cases where a backup is performed on certain files, but the regular backup routines are unaffected because the copy backup does not alter the archive bit.

The *daily* backup option backs up only files that have been changed or updated on the day the backup is performed. It leaves the archive attribute unchanged, so regular backups are not affected. A daily backup is valuable, for example, when there is a failing hard disk and little time to save the day's work to that point. It enables the administrator to save only that day's work, instead of all changed files, which may span more than a day.

To perform a tape backup of all files on drive C, for example, you need to have the tape system installed, and you need enough formatted blank tapes to hold the information you plan to back up from the server. Before starting a backup it may be necessary to format a new tape or retension new and used tapes.

Both tasks are performed from the Microsoft Backup tool's Restore tab in one of two ways. One way is to click the medium in the Name box, click the Tools menu, point to Media Tools, and select Format or Re-tension. Another way is to right-click the medium in the Name box on the Restore tab to access the Format and Re-tension options (plus other options for that particular medium). The Backup tool is opened by clicking the Start button, pointing to Programs, pointing to Accessories, pointing to System Tools, and clicking Backup. Formatting deletes existing information and automatically retensions a tape. Retensioning makes sure the tape starts from the beginning of the reel, so there is no slack that may cause lost data.

Once the tape is inserted and ready, you can perform a backup by using the Backup Wizard from the Welcome tab or by manually creating a backup from the Backup tab (see Figure 7-10). Each type of backup can be created with a job name so that you can perform the same backup over and over using that job name, or specify that name to schedule a backup job that is run unattended. Hands-on Project 7-7 enables you to practice making a backup.

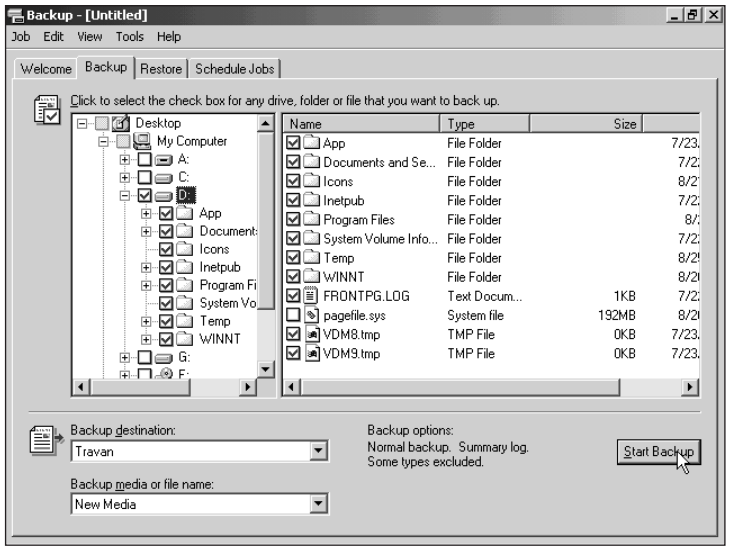


Figure 7-10 Manually starting a backup

Scheduling Backups

Windows 2000 Server includes a scheduling capability so that you can have the server automatically start backups after regular work hours or at a specific time of day. For example, you may schedule full backups to start at 7:00 p.m. after everyone has left work. An accounting office in an organization may perform a daily closing routine in which they stop processing by 4:20 p.m. and back up accounting files at 4:30 p.m. After the backups are complete, another process might start at 6:00 p.m., via the Windows 2000 Scheduled Tasks tool in the Control Panel, which closes out that day's activities and prepares accounting files for the next day.

The following general steps illustrate how to schedule a backup:

1. Click Start, point to Programs, point to Accessories, point to System Tools, then click Backup.
2. Select the drives and folders that you want to back up.
3. Click Start Backup.
4. Provide the backup job information such as the backup description, how to write on the media, and a label for the backup.

5. Click the Schedule button and click Yes.
6. Provide a filename in which to store the selection parameters for the backup job, and click Save.
7. Provide a password for the account from which the job will run, and confirm the password. Click OK.
8. Enter a job name.
9. Click the Properties button to specify the scheduling information, such as how often to run the backup, the start time, and the day or days of the week on which to run it. Figure 7-11 shows the display after you select Weekly in the Schedule Task box. Click OK and OK again.

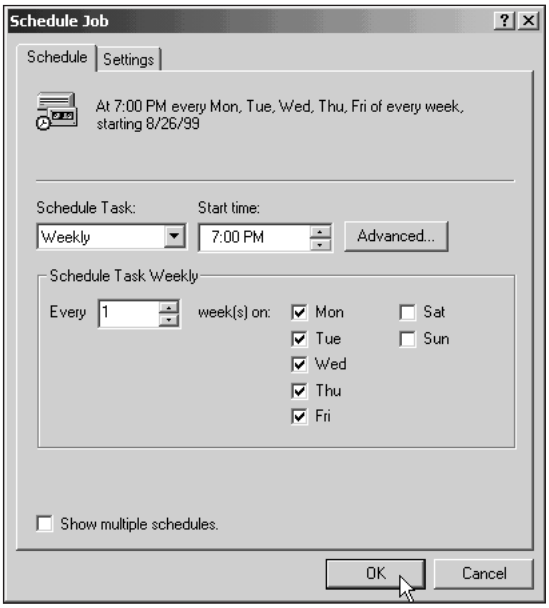


Figure 7-11 Scheduling a backup job

After a job is scheduled, you can modify the job parameters by accessing the Schedule Jobs tab in the Backup tool, clicking the job on the calendar, and clicking Properties in the Scheduled Job Options dialog box. Also, Windows 2000 includes wizards to set up a backup and schedule it. Click the Welcome tab in the backup tool to start a wizard.

Performing a Restore

Use the Backup tool to perform a restore from removable media. The Restore Wizard on the Welcome tab will step you through the process of a restore, or you can use the Restore tab. If you use the Restore tab, follow these steps:

1. Open the Backup tool and click the Restore tab.
2. Insert the medium from which to perform the restore, such as a tape or Zip disk.
3. In the left pane, double-click the medium from which to perform the restore, such as File (for a Zip drive, for example) or Travan (for a tape drive). In the right pane (or on the left pane under the medium) find the label of the backup that you want to restore, and double-click it.
4. Double-click down through the levels of the drives, folders, and subfolders to find what you want to restore. Place a checkmark in front of the drives, folders, and files that you want to restore.
5. In the *Restore files to* box, select a location to which to restore the files and folders. The options are to restore to the original location, to restore to an alternate location, or to restore to a single folder. The first two options retain the original folder structure as reflected on the backup medium. In the third option, restore to a single folder, the original folder structure is not retained, which means that the target folder will contain only files after the restore.
6. Click the Start Restore button.
7. Click Advanced on the Confirm Restore dialog box if you want to modify any of the restore options—for example, if you want to restore security information. Click OK if you decide to modify the advanced options.
8. Click OK to start the restore. Prior to starting, you may be prompted to supply the location, if you are restoring from a file.
9. Click Close and close the Backup tool.

Configuring for Performance

Besides properly setting up disk resources for fault tolerance and performance, you can immediately tune the server to improve performance. Three ways to tune the server are for application priority, for virtual memory, and to set memory to match the number of users on the server.

Configuring Application Performance

A Windows 2000 Server can be tuned to give the most processor priority to applications that are running in the foreground or to give foreground and background applications equal processor priority. Foreground applications are those you are likely to be running at the server console, such as the Backup tool. Background applications are those typically

accessed by users, such as logon verification, printing services, and any other server services. In most cases you will tune the server to give equal processor access to both foreground and background processes, which is the default. Sometimes you may need to give foreground processes most of the processor's resources, for instance when you determine that a disk drive is failing and you want to back up its contents as fast as possible via the Backup tool at the console.

Application performance is configured through the Control Panel System icon. There are two settings that you can configure: (1) Applications, which gives priority to foreground applications, and (2) Background services, which gives equal processor time to all applications and services. Hands-on Project 7-8 gives you experience in tuning application performance.

Configuring Virtual Memory

Virtual memory is disk storage that Windows 2000 Server uses to expand the capacity of the physical RAM installed in the computer. When the currently running programs and processes exceed the RAM, they treat disk space allocated for virtual memory just as if it is real memory. The disadvantage of this is that memory activities performed through virtual memory are not as fast as those performed in RAM (although disk access and data transfer speeds can be quite fast). Virtual memory works through a technique called **paging**, whereby blocks of information, called pages, are moved from RAM into virtual memory on disk. On a Pentium computer, data is paged in blocks of 4 KB. For example, if the system is not presently using a 7 KB block of code, it divides the code block between two pages, each 4 KB in size (part of one page will not be completely full). Next, both pages are moved to virtual memory on disk until needed. When the processor calls for that code block, the pages are moved back into RAM.

Before virtual memory can be used, it must first be allocated for this purpose by tuning the operating system. The area of disk that is allocated for this purpose is called the **page file**. A default amount of virtual memory is always established when Windows 2000 Server is installed, but the amount should be checked by the administrator to ensure that it is not too large or too small.

Besides size, the location of the page file is important. Some tips for locating the page file are:

- Server performance is better if the page file is not placed on the boot partition of basic disks or the boot volume of dynamic disks.
- If there are multiple disks, performance can be improved by placing a page file on each disk (but avoid placing the page file on the boot partition or volume).
- In a mirrored set or volume, place the page file on the main disk, and not on the mirrored (backup) disk.
- Do not place the page file on a stripe set, striped volume, stripe set with parity, or RAID-5 volume.

The page file is called Pagefile.sys and can be viewed at the root level by using Windows Explorer or My Computer.

A general rule for sizing a page file is to start with the size recommended when you view the virtual memory settings via the Control Panel System icon, which is the amount of installed RAM times 1.5. For a server with 256 MB of RAM, the page file should be at least 384 MB (256 × 1.5). To set virtual memory, open the Control Panel, double-click the System icon, click the Advanced tab, click the Performance Options button, and click the Change button. Highlight the drive to contain the page file. Set the initial page file size to match your calculation for the size that is needed. Set the maximum size so it affords plenty of room for growth—twice the size of your initial page file setting. For example, if your initial setting is 384 MB, then consider setting the maximum size to 768 MB. Windows 2000 Server always starts at the initial size and only uses additional space as needed. Click the Set button to implement the change (see Figure 7-12).

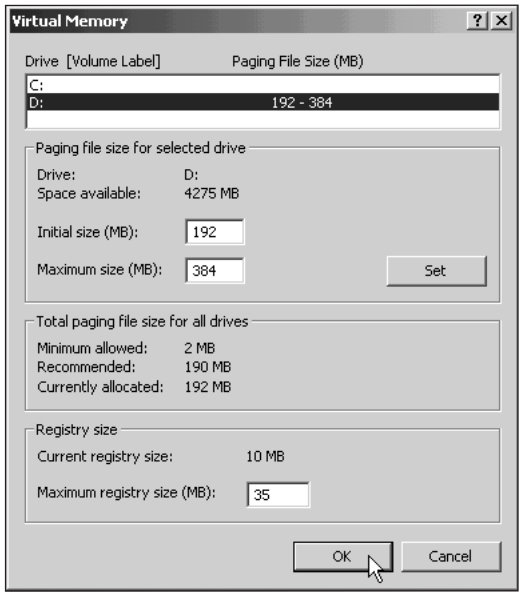


Figure 7-12 Configuring vitual memory

Also, there is a box to set the maximum size for the Registry file. As a general rule, the maximum Registry size is 18 to 25 percent of the initial page file size, which is about 70 MB for an initial page file size of 384 MB. Click OK to save the changes, and click OK twice more to leave the System Properties dialog box. Hands-on Project 7-8 gives you practice in tuning virtual memory.

Configuring Memory to Match the User Load

Memory is divided between server functions and network connectivity functions. The server functions include software applications, printing, and currently running services. Network connectivity is related to the number of user connections at a given time. Server functions use RAM and paging. The network connectivity only uses RAM. If the server performance is slow because memory is busy, the network memory parameters should be checked and tuned.

Network memory is adjusted from the Network and Dial-up Connections icon in the Control Panel (or on the Start button Settings menu). Open Network and Dial-up Connections, right-click Local Area Connection, and click Properties. Scroll the installed components list to find File and Printer Sharing for Microsoft Networks, and double-click that component to view the dialog box shown in Figure 7-13.

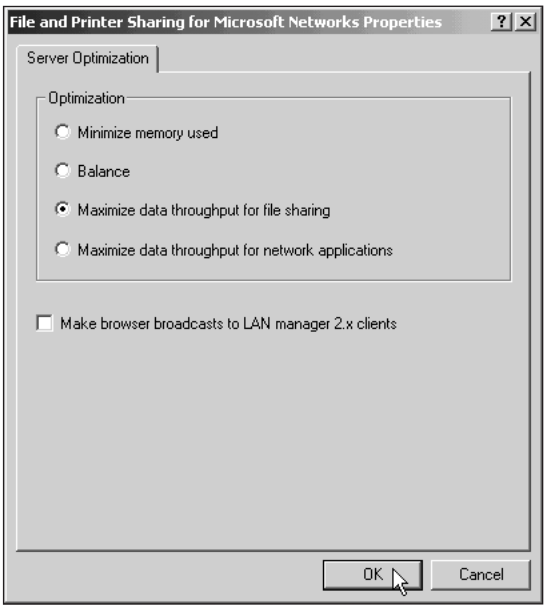


Figure 7-13 Adjusting memory allocation

The memory optimization settings are described in Table 7-2. For example, if a server has 120 users who regularly access Microsoft Access database files on the server, or who regularly install software from the server, the Maximize data throughput for file sharing option should be checked; or, if there are only 32 users on a small network, check the Balance radio button.

The memory settings shown in Table 7-2 are based primarily on how caching is handled compared to working sets. Caching involves storing often-used information, such as the contents of a file, in memory. A working set involves assigning physical memory to a process, for example to software application code. The *Minimize memory used* setting simply uses the minimum amount of memory for logged-on users. *Balance equally* divides memory use

between caching and working sets. *Maximize data throughput for file sharing* gives caching most priority for use of available memory. *Maximize data throughput for network applications* gives working sets most memory and caching least memory.

Table 7-2 Configuring Server RAM

Optimizing Memory Settings	Purpose
Minimize memory used	Optimizes the memory used on servers with 10 or fewer simultaneous network users
Balance	Optimizes memory use for a small LAN with 64 or fewer users
Maximize data throughput for file sharing	Used for a large network with 64 users or more where file serving resources need more memory allocation to make the server efficient
Maximize data throughput for network applications	Used in servers that primarily handle network connections and to reduce paging activity when this affects server performance
Make browser broadcasts to LAN manager 2.x clients	Used for networks that have both Windows 2000 Server and Microsoft's early server operating system, LAN Manager

UPS Fault Tolerance

Disk drives, memory, and other key server components can sustain damage from power outages and fluctuations, such as brownouts. Also, the server may lose valuable data when a sudden power problem causes it to shut down without the opportunity to save data. A **UPS** (**uninterruptible power supply**) is the best fault tolerance method to prevent power problems from causing data loss and component damage.

There are two kinds of UPS systems commonly marketed: online and offline. Online UPS systems provide electrical power to equipment directly from their batteries. Their batteries are always charging from city power, until a power failure strikes. An offline UPS connects city power directly to the electrical equipment until it senses a sudden reduction in power, at which time it switches over to batteries. The advantage of an offline UPS is that it is less expensive than the online variety, and batteries often last longer. The disadvantage is that it may not switch to battery power in time to fully protect equipment during a sudden power failure. For this reason, many people prefer online systems for more guaranteed protection.

All UPS systems are designed to provide power for a limited time period, such as 10 to 20 minutes, so a decision can be made about how long the power failure will last and whether to shut down computers immediately. Of course, the amount of time the batteries can provide power depends on how much and what equipment is attached to the UPS. This is why most people attach only critical equipment to a UPS, such as computers and monitors, external disk arrays, and tape drives.

Some manufacturers recommend that laser printers not be plugged into a UPS, because those printers draw excessive power when turned on, risking damage to the UPS.

Most UPSs include circuitry to guard against power surges, which send so much power through electrical lines that it may damage motors, power supplies, or electronic components in equipment. Additional circuits may be present in offline UPSs to protect against power brownouts, or sags when not enough power is available. An online UPS normally regulates power to provide insurance for brownouts as well as outages. Also, many systems have protection for modem lines in case lightning strikes telephone lines. Another feature of modern UPS systems is the ability to communicate information to the computers they support, such as a warning that the power is out or that the UPS batteries are low.

Before connecting a server to a UPS, unpack the equipment and inspect it. Check to be sure a serial cable is included for communications with the server. Follow the manufacturer's directions for setting up the UPS. These directions may include, for example, inspecting the equipment, then shutting down the server, attaching the UPS serial cable to a serial communications port on the server, such as port 2 (COM2), plugging the UPS into the wall outlet, and plugging the server, monitor, and tape drive power cords into the UPS. Turn on the UPS and then power up the server.

The server and UPS communications options are set up in Windows 2000 Server from the Control Panel Power Options icon. After you open the Power Options tool, click the UPS tab to configure the communications for your particular UPS:

1. Click the Select button.
2. Use the Select manufacturer list box to select the UPS manufacturer, such as American Power Conversion.
3. Select the specific UPS model, such as the PowerStack, in the Select model list box.
4. In the *On port* box, specify the COM port to which the UPS is attached, such as COM2. Click Finish.
5. Click the Configure button in the Power Options Properties dialog box.
6. Configure the options that are appropriate to the UPS, which include how to send out notifications of a power failure, when to sound a critical alarm that the UPS is almost out of power, the ability to run a program just before the UPS is out of power, and if you want the computer and UPS to shut down just before the UPS is out of power. Click OK.
7. Click Apply.

8. Check the message at the bottom of the dialog box to make sure that the UPS is connected and communicating with the server. A large "X" in a red circle appears if it is not properly connected and communicating. If it does not, make sure that the serial cable is attached, ensure that you configured the same server port in Step 4 as is used for the cable, and make sure that the UPS is turned on.
9. Click OK and close the Control Panel.

CHAPTER SUMMARY

- Disk and removable storage management represents one of the most important advancements in Windows 2000 Server. The operating system provides two kinds of disk setup: basic and dynamic. Basic disks are backward-compatible to earlier operating systems, such as Windows NT Server, and provide rudimentary disk handling. Dynamic disks can be configured for more comprehensive disk management involving simple, spanned, striped, and RAID-5 volumes. Both basic and dynamic disks can be mounted to eliminate the need to identify them via a drive letter.
- Windows 2000 Server employs removable storage that includes tapes, CD-ROMs, CD-RWs, Zip, and Jaz drives. Removable storage is managed through libraries and media pools. Backups that are performed through the Windows 2000 Server Backup tool are one example of the automated use of media pools. Most server administrators back up their servers on a regular basis, using one or more of the backup techniques offered in Windows 2000 Server, such as the full or normal backup. Backups are a simple, but vital, form of insurance against lost data.
- After you set up a server, there are three immediate steps that you can take to tune performance. These include tuning how applications run, adjusting virtual memory, and tuning how memory is used for network connectivity. Finally, another important step to guarantee uninterrupted performance is to obtain and configure a UPS.

In the next chapter, you move from strictly working on the server to preparing both server and workstations for client access to the network.

KEY TERMS

active partition — The partition from which a computer boots.

basic disk — In Windows 2000, a partitioned disk that can have up to four partitions and that uses logical drive designations. This type of disk is compatible with MS-DOS, Windows 3.x, Windows 95, Windows 98, Windows NT, and Windows 2000.

boot partition — Holds the Windows 2000 Server \Winnt folder containing the system files.

defragmentation — A software process that rearranges data to fill in the empty spaces that develop on disks and make data easier to obtain.

disk fragmentation — A normal and gradual process in which files become spread throughout a disk, and empty pockets of space develop between files.

dynamic disk — In Windows 2000, a disk that does not use traditional partitioning, which means that there is no restriction to the number of volumes that can be set up on one disk or to the ability to extend volumes onto additional physical disks. Dynamic disks are only compatible with Windows 2000.

extended partition — A partition that is created from unpartitioned free disk space and is linked to a primary partition in order to increase the available disk space.

formatting — A process that prepares a hard disk partition for a specific file system.

full backup — A backup of an entire system, including all system files, programs, and data files.

home folder or **home directory** — A server folder that is associated with a user's account and that is a designated workspace for the user to store files.

incremental backup — A backup of new or changed files.

library — Removable storage media and the drive (or drives) used by the media.

master boot record (**MBR**) — Data created in the first sector of a disk, containing startup information and information about disk partitions.

media pool — A set of removable media in which the media are used for the same purpose and are managed in the same way, such as backup tapes for a Windows 2000 server.

mirrored volume — Two dynamic disks that are set up for RAID level 1 so that data on one disk is stored on a redundant disk.

mounted drive — A physical disk, CD-ROM, or Zip drive that appears as a folder and that is accessed through a path like any other folder.

page file — Disk space reserved for use when memory requirements exceed the available RAM.

paging — Moving blocks of information from RAM to virtual memory on disk.

partitioning — Blocking a group of tracks and sectors to be used by a particular file system, such as FAT or NTFS.

partition table — Table containing information about each partition on a disk, such as the type of partition, size, and location. Also, the partition table provides information to the computer about how to access the disk.

primary partition — Partition or portion of a hard disk that is bootable.

RAID-5 volume — Three or more dynamic disks that use RAID level 5 fault tolerance through disk striping and creating parity blocks for data recovery.

Registry — A database used to store information about the configuration, program setup, devices, drivers, and other data important to the setup of a computer running Windows 2000, Windows NT, Windows 98, or Windows 95.

robotic library — A library of removable media and drives in which multiple media, such as tapes, can be mounted and dismounted automatically.

simple volume — A portion of a disk or an entire disk that is set up as a dynamic disk.

spanned volume — Two or more Windows 2000 dynamic disks that are combined to appear as one disk.

stand-alone drive library — A library consisting of media and a drive, in which the media are mounted manually one at a time.

stripe set — Two or more basic disks set up so that files are spread in blocks across the disks.

striped volume — Two or more dynamic disks that use striping so that files are spread in blocks across the disks.

system partition — Partition that contains boot files, such as Boot.ini and Ntldr in Windows 2000 Server.

uninterruptible power supply (**UPS**) — A device built into electrical equipment or a separate device that provides immediate battery power to equipment during a power failure or brownout.

virtual memory — Disk space allocated to link with memory to temporarily hold data when there is not enough free RAM.

volume — A basic disk partition that has been formatted for a particular file system, a primary partition, a volume set, an extended volume, a stripe set, a stripe set with parity, or a mirror set. Or a dynamic disk that is set up as a simple volume, spanned volume, striped volume, RAID-5 volume, or mirrored volume.

volume set — Two or more formatted basic disk partitions (volumes) that are combined to look like one volume with a single drive letter.

Review Questions

1. You notice that one of the servers in your organization seems to run slowly because there is heavy paging activity. What can you do to reduce the paging?
   a. Mount the page file on CD-ROM.
   b. Delete the page file and recreate it at half the size.
   c. Configure the server memory to maximize data throughput for network applications.
   d. Configure the server memory so it is balanced.
2. You want to set up two disks so they are mirrored, but there is no option to do this in the Disk Management snap-in. What is the problem?
   a. Windows 2000 no longer supports mirroring.
   b. You are working with basic disks and need to convert them to dynamic disks.
   c. You must stripe the disks first.
   d. The disks must contain over 2 GB to mirror them.
3. Which of the following are examples of libraries?
   a. robotic
   b. stand-alone
   c. synchronized
   d. all of the above
   e. only a and b
   f. only b and c

4. Your server has 512 MB of RAM, and your colleague who is also a server administrator wants to set the minimum page file size at 256 MB as a way to save on disk space. What is your reaction?
   a. You agree that this is a good way to conserve disk space.
   b. You do not agree because the page file size should be at minimum 1 GB for Windows 2000 Server.
   c. You do not agree because the page file size should be at minimum 768 MB.
   d. You agree, but recommend reducing the minimum even more to 125 MB.
5. Your organization is growing and becoming more dependent on its servers. One result is that tape backups now require about 2–3 hours to complete. Your boss is concerned about the after-work hours that you spend nursing the backups, waiting for each tape to finish and then inserting another until the backups are complete. What solution(s) might you suggest that are compatible with Windows 2000 Server?
   a. Purchase a robotic tape unit to load tapes automatically.
   b. Schedule the backups.
   c. Only perform backups every other day.
   d. all of the above
   e. only a and b
   f. only b and c
6. How much free space is needed on a basic disk to convert it to a dynamic disk?
   a. 1 MB
   b. 5 MB
   c. 10 MB
   d. none
7. Which of the following is(are) true about basic and dynamic disks?
   a. Dynamic disks can be partitioned, but basic disks cannot.
   b. Dynamic disks can be set up as spanned volumes.
   c. Basic disks are formatted, but dynamic disks are not.
   d. All of the above are true.
   e. Only a and b are true.
   f. Only a and c are true.
8. You want to set up a mounted volume on your Windows 2000 Server. As you go through the steps to mount the volume in the Disk Management snap-in, you find there is no option to mount the volume. What is the problem?
   a. The disk containing the target folder for the mounted volume is formatted for FAT and not NTFS.
   b. You did not first set up the target folder as a shared resource.

c. The target folder is not compressed.

d. Only a CD-ROM can be mounted, and you are trying to mount a dynamic disk.

9. You want to view the properties of the page file. Which of the following files would you right-click to view the properties?

   a. Ntdetect

   b. Pagefile.com

   c. Pagefile.sys

   d. Netcom.dat

10. You want to locate the media pool for the backups that you are running. Which tool provides this information about the media pool and enables you to manage it?

    a. Disk Management

    b. Removable Storage

    c. System Tools

    d. Backup

11. What is the dynamic disk called that contains the \Winnt folder?

    a. boot folder

    b. system partition

    c. system disk

    d. boot volume

12. Your server, which is set up for basic disks, will not boot. When you run an independent disk analysis tool from the disk manufacturer, it shows that the disk and the disk adapter are both working properly. What else might be the problem?

    a. Windows 2000 is trying to boot too fast for that disk.

    b. The disk is formatted as a simple volume and has lost it parity data.

    c. The master boot record is damaged.

    d. all of the above

    e. only a and b

    f. only a and c

13. You are new to an organization that is in the practice of throwing out tapes that contain old information but that are still usable. Which of the following might you suggest for this organization?

    a. Create a free media pool for a managed way to cycle the tapes back into use.

    b. Create an application media pool as a means to delete information on the tapes before they are thrown out.

    c. Have server operators manually erase and retension the tapes to be used again.

    d. Use a magnet to quickly initialize each tape so it can be reused.

14. As a consultant, you have been asked to improve the performance of a server that has a mirrored volume containing the \Winnt folder, a RAID-5 volume of seven physical disks, a simple volume labeled F:, and another simple volume labeled G:. When you check the location of the page file, you find one page file on the main disk of the mirrored volume. Would you make any changes?
    a. The current setup is the ideal setup in this situation.
    b. Add a page file to the RAID-5 volume.
    c. Add a page file to each of the F: and G: volumes.
    d. Remove the page file from the main disk in the mirrored volume and put it on the RAID-5 volume.
15. Virtual memory is an example of
    a. allocating a section of RAM only for the operating system.
    b. using disk space to supplement RAM.
    c. using memory exclusively for network connectivity.
    d. giving applications running on the server priority for RAM access.
16. Which of the following backup options are you most likely to use when you want to back up all files on a server?
    a. copy
    b. incremental
    c. differential
    d. normal
    e. daily
17. How many partitions can you put on a dynamic disk?
    a. 1
    b. 2
    c. 4
    d. none
18. Your organization only has 12 users on the server. What setting would you use to configure memory use?
    a. Balance
    b. Maximize data throughput for file sharing
    c. Maximize data throughput for network applications
    d. Minimize memory used

19. You are setting up a server for a customer service organization that needs fast access to its data, but that is not as concerned about how fast information is updated on disk. The organization wants fault tolerance for data storage. Which of the following options would you recommend?
    a. a spanned volume
    b. a striped volume
    c. a RAID-5 volume
    d. a simple volume
20. In order to boot from a basic disk, which of the following must be true?
    a. It is a primary partition.
    b. It is an active partition.
    c. It is designated as drive C.
    d. all of the above
    e. only a and b
    f. only b and c
21. You are consulting for a small organization that has used their server for over two years without maintaining it, other than to replace a defective monitor. They are complaining that the server performance has gotten slower over the past several months. What would you do first to improve performance?
    a. Add RAM.
    b. Set memory to Make browser broadcasts to LAN manager 2.x clients.
    c. Increase the page file size by 300–500 MB.
    d. Defragment the disks.
22. You have created a RAID-5 volume that consists of seven 9-GB disks. How much disk space is usable to store files?
    a. all of the disk space
    b. 54 GB
    c. 62 GB
    d. 60 GB
23. Which of the following can be used in removable storage management?
    a. Jaz drive
    b. CD-ROM drive
    c. tape drive
    d. all of the above
    e. only a and b
    f. only b and c

24. You have set up a spanned volume, and one disk has failed. What are your alternatives?
    a. There is no problem because the other disks will take over.
    b. Use the Disk Management snap-in to start the parity repair tool.
    c. Replace the disk, repair the spanned volume, and perform a full restore.
    d. Use the Disk Management snap-in to make the remaining disks simple volumes, and then recover the data.
25. How many extended partitions can be on one basic disk?
    a. 1
    b. 2
    c. 4
    d. none

HANDS-ON PROJECTS

Project 7-1

In this hands-on activity you install the Disk Management and Disk Defragmenter snap-ins in the MMC. Next, you practice partitioning and formatting a basic disk.

To install the snap-ins:

1. Click **Start** and click **Run**. Enter **mmc** in the Open: box and click **OK**.
2. Maximize the Console windows, if necessary. Click the **Console** menu and click **Add/Remove Snap-in**.
3. Click the **Add** button and double-click **Disk Management**. Click **Local Computer** and click **Finish**.
4. Double-click **Disk Defragmenter**. Click **Close** and click **OK**.
5. Click the **Console** menu and click **Save As**. Enter **Disk.msc** as the name for this Console setup and click **Save**. Now you can access it in the future as Disk.msc from the Administrative tools menu or the MMC, so that you do not have to install the snap-ins again.

To partition and format a basic disk:

1. Double-click the **Disk Management** folder in the MMC tree.
2. Right-click an unallocated portion of disk space. Note that black is the default color that designates unallocated disk space.
3. Click **Create Partition**. Click **Next** in the Create Partition Wizard.
4. Click **Primary partition** and click **Next**.
5. Enter the amount of disk space to use, such as **8411** MB. The Wizard provides information about the minimum and maximum amount of space that you can specify, on the basis of the total unallocated space (see Figure 7-14). Click **Next**.

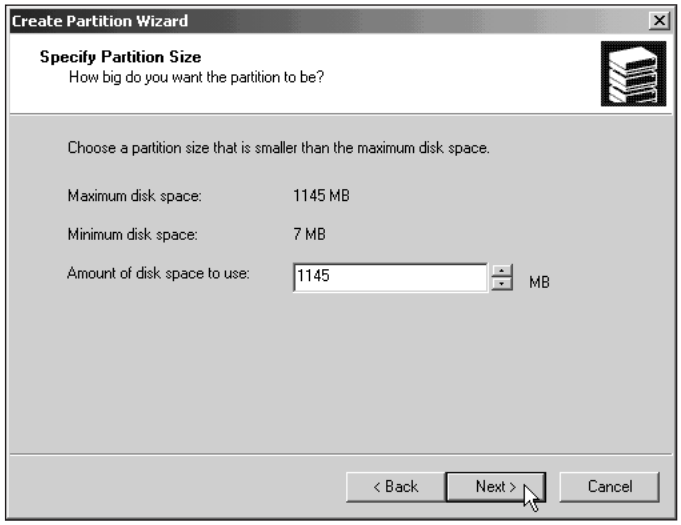


Figure 7-14 Specifying the amount of disk space for a new partition

6. Assign a drive letter, such as **D:** (or the next available drive letter). Click **Next**.
7. Click **Format this partition with the following settings:** Select the option to format using NTFS (but view the other options before you make your selection). Select **512** in the Allocation unit size: box (look at all of the options). Enter **Databases** as the volume label. Check the box to **Enable file and folder compression**. Click **Next**.
8. Use the scroll bar to review the settings you have specified. If you want to change any, click the Back button until you reach the appropriate dialog box. Record your observations about the options in this dialog box.
9. Click **Finish** when you are ready to create the partition and format it. (If you are just practicing and do not want to create the partition, click Cancel.)
10. Close the MMC.

Project 7-2

In this project, you practice marking a basic disk partition as the active partition (system partition) containing the boot files. The system that you use should have at least two partitions. If it does not, you can still view the option to mark a partition as active, but that option will be deactivated.

To mark the partition:

1. Click **Start** and click **Run**. Enter **mmc** in the Open: box and click **OK**.
2. Maximize the Console windows, if necessary.
3. Click **Console**, click **Open**, and double-click **Disk.msc**, which is the console file you created in Hands-on Project 7-1.

4. Notice the partitions available on the computer and record their sizes, file systems, and other information in your lab journal or in a word-processed document.
5. Find a partition that is not labeled as "(System)" and right-click it.
6. Notice the Mark Partition Active option on the shortcut menu. This is the option you would click to mark a partition as active. (Do not mark the partition active in this practice session, unless your instructor gives you permission.)
7. Click an empty portion of the Console window to close the shortcut menu, but leave the Console window open for projects that follow.

Project 7-3

In this hands-on activity, you practice changing the drive letter of an existing drive.

To change the drive letter:

1. Make sure that the Console window is open, with the Disk Management snap-in installed and open.
2. Right-click a drive, such as **C:** or **D:**, and click **Change Drive Letter and Path**.
3. Click the **Edit** button. What happens if you try to edit a boot or system partition or volume? Repeat Steps 2 and 3 for another volume if you right-clicked a boot or system volume in Step 2.
4. Click the **Assign drive letter**: radio button (if it is not selected by default), and view the drive letter options in the list box (see Figure 7-15). What drive letters are available on your computer?

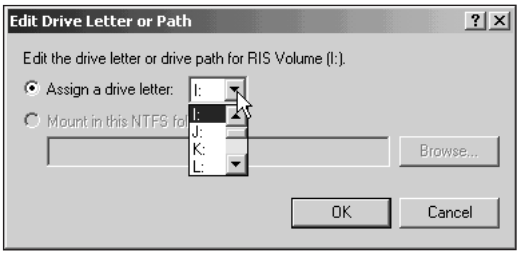


Figure 7-15 Changing the drive letter

5. Change the drive letter to a different letter than is already assigned, such as **G:**, and click **OK**.
6. What is the warning box that appears?
7. Click **Yes** if you have permission from your instructor to change the drive letter; if not, click **No** and click **Close**.
8. If you clicked Yes in Step 7, notice that the new drive letter is shown in the Disk Management snap-in.

Project 7-4

This Hands-on Project gives you the opportunity to create a simple volume for a dynamic disk. Before starting, the disk should be converted to a dynamic disk (see the section "Converting Disks," and follow those steps if it is not already converted).

To create the simple volume:

1. Make sure that the Console window is open, with the Disk Management snap-in is installed and open.
2. Right-click free space on a disk.
3. Click **Create Volume**. Click **Next** in the Create Volume Wizard.
4. Make sure the selection to create a Simple Volume is selected. Click **Next**.
5. Click **Next** in the Select Disks dialog box.
6. Click **Assign a drive letter** and use the default drive letter. Click **Next**.
7. Make sure the Format Volume dialog box is set for **NTFS**. Click **Next**.
8. Click **Finish**.
9. Click the **Action** menu and click **Rescan Disks**, if the volume is not displayed in the Disk Management snap-in.

Project 7-5

In this activity you practice analyzing a disk and then defragmenting it.

To analyze and defragment the disk:

1. Make sure that the Console window is open, with the Disk Defragmenter snap-in is installed.
2. Click **Disk Defragmenter** in the left pane.
3. Right-click a disk drive, such as drive **C**: and notice the options that are available. Make a note of these in your lab journal or a word-processed document. Click **Analyze**.
4. Does this disk need to be defragmented? If so, how much fragmentation exists (click the **View Report** button)?
5. Click **Defragment** in the Analysis Complete dialog box (even if it reports that you do not need to defragment).
6. What information is shown on the screen during the defragmenting process?
7. Click **View Report** in the Defragmentation Complete dialog box.
8. What information is shown in the report? Summarize the information in your lab journal or in a word-processed document.
9. Click **Close** to exit the report.

Project 7-6

In this project you create a mounted volume. In the first series of steps, you create a folder on an NTFS formatted volume or disk that will hold the mounted drive. After those steps, you mount the drive into the folder.

To create the mounted drive:

1. Open Windows Explorer or My Computer and click a main volume that is formatted for NTFS, such as drive **C:**.
2. Click the **File** menu, highlight **New**, and click **Folder**. Enter your initials appended to Mount for the folder name, for example MPMount. Press **Enter**.
3. Make sure that the Console window is open, with the Disk Management snap-in installed.
4. Right-click the disk drive you want to mount into the folder, and click **Change Letter and Drive Path**.
5. Click the existing drive letter for the drive, such as **D:** in the Name box, and click the **Add** button.
6. Click **Mount in this NTFS folder**.
7. Click the **Browse** button and locate the folder you created, then click that folder (for example, **MPMount**).
8. Click **OK** in the Browse for Drive Path dialog box.
9. Click **OK** in the Add New Drive Letter or Path dialog box (or click Cancel if you do not want to complete mounting the drive).
10. Go back to Windows Explorer or My Computer and find the mounted volume you created. What icon is used to represent it?
11. Right-click the mounted volume to examine its properties. Record your observations about the mounted volume's icon and properties in your lab journal or a word-processed document.
12. Close the mounted volume's properties dialog box and close Windows Explorer or My Computer.

Project 7-7

In this activity you practice backing up a disk drive. You will need a computer running Windows 2000 Server that is set up for a tape drive, and you will need a tape.

To practice a backup:

1. Insert a tape into the tape drive of the computer.
2. Click **Start**, point to **Programs**, point to **Accessories**, point to **System Tools**, and click **Backup**.
3. Click the **Backup** tab.

4. Check the box of a drive on the computer, such as drive **C:** or **D:**. Double-click that drive and notice which folders are checked for the backup. How would you back up only a portion of a drive, such as one or two folders? Record your observations in your lab journal or a word-processed document.
5. In the Backup destination box, select the backup medium that reflects the type of tape you are using, such as **Travan** or **4mm DAT**.
6. Click the **Start Backup** button.
7. Enter a description and label for the backup, such as **Set created 7/2/2000 at 10:00 AM** and **Media created 7/2/2000 at 10:00 AM**. If you are using a new tape or an old one that you can write over, click **Replace the data on the media with this backup**. If instead you want to retain data already on the tape, click **Append this backup to the media**.
8. Click the **Advanced** button.
9. Click **If possible, compress the backup data to save space**.
10. Click the **Backup Type** list box and view the options. Record the options in your lab journal or in a word-processed document, and note which dialog box enables you to access them. Select **Normal** as the option for this backup.
11. Click **OK**.
12. Click the **Start Backup** button (or you can click Cancel if you do not have a tape for practice). After you click the Start Backup button, you may see a dialog box with a warning that "There is no 'unused' media available," which means that the tape has been used previously. Click **Yes** if you see this warning.
13. Click **OK** when the backup is complete, and then close the Backup utility.

Project 7-8

In this project, you tune Windows 2000 server by setting the application response and changing the virtual memory allocation.

To tune the server:

1. Click **Start**, point to **Settings**, and click **Control Panel**.
2. Double-click the **System** icon and click the **Advanced** tab.
3. Click the **Performance Options** button.
4. Click **Applications**.
5. Click the **Change** button.
6. What is the current paging file size? Is it set at the recommended initial size? Is there a page file on more than one volume? Record your findings in a lab notebook or word-processed document.
7. Click drive **C:** or another drive containing a paging file.
8. Change the initial paging file size so that it is 10 MB over the current initial size, by entering this value in the Initial size (MB): box.

9. In the Maximum (MB): box, enter a value that is 10 MB over the currently entered size.
10. Click **Set**.
11. Click **OK** to exit the Virtual Memory dialog box, and click **OK** to leave the Performance Options dialog box.
12. Click **OK** to leave the System Properties dialog box.

CASE PROJECT

Aspen Consulting Project: Configuring Storage and Performance

Country Fresh Breads is a large bakery in Los Angeles that supplies baked goods to grocery and convenience stores. Their information technology group is implementing a new server with Windows 2000 Server that will be used to track sales and distribution data. Sales are handled over the telephone by customer representatives, who take weekly orders from grocery stores for bakery items to be delivered. Currently, Country Fresh Breads is using an aging UNIX server for the sales and distribution functions. The Country Fresh Breads customer representatives look up information when each store calls and then place the store's order via the computer. The disk response time on the UNIX server is relatively slow, and they are hoping to have faster look-up response on the new Windows 2000 server. The new server has a disk array containing eight 20 GB disks. Four of the disks are on one SCSI adapter, and four are on another SCSI adapter. The information technology group is contacting you to help in setting up the server. Their current need is to have you assist with the disk storage and in setting up backups.

1. What type of disk storage do you recommend that Country Fresh Breads use on this server: basic or dynamic disks? Why?
2. What fault tolerance do you recommend that they use, if any? If you do recommend fault tolerance, explain how to set it up.
3. The company wants to use one disk on this server for users' home folders. Explain how you would implement the disk for this purpose and what steps to follow in setting it up.
4. This server will have a CD-ROM jukebox that can hold up to five CD-ROMs, but Country Fresh Breads intends to make 15 CD-ROMs available for company-wide access. What Windows 2000 Server tool(s) can be used to track the CD-ROMs and notify operators to mount CD-ROMs as needed?
5. Explain how you would set up backup systems for the following purposes:
   - Daily backups of the server
   - Weekly backups of sales information contained in five folders to import into the accounting system on another server
   - Yearly archiving of all sales data
6. The information technology group is not sure how to adjust the page file. Explain how to size the file, and provide instructions about what steps to use in the process.

OPTIONAL CASE PROJECTS FOR TEAMS

Team Case One

Mark Arnez is curious about how many ways there are to use mounted volumes in different kinds of situations. Form a team to develop a range of scenarios in which to use mounted volumes.

Team Case Two

Tape technologies are changing—the recent improvements in Travan technology are one example. Mark asks you to form a group to research the different kinds of tape technologies that are compatible with Windows 2000 Server. Which of these technologies can be used with libraries and media pools?